

HW 6 Key

Short answer (30 pts)

1. (5 pts) The rings are either a satellite that broke into particles, or are particles that were never able to come together to form a satellite.
2. (5 pts) The Roche limit is the maximum distance at which an unconsolidated satellite will be disrupted (broken apart) by tidal forces. Essentially all planetary rings that we know of are inside the Roche limit; Saturn's E, F, and G rings are special cases with shepherding satellites.
3. (5 pts) The "surface" of Jupiter is not even solid, let alone well defined, but is a somewhat arbitrary depth (tropopause or minimum T) into the atmosphere. The temperature there is only 100K. About 100km deeper, the temperature is about like the surface of the Earth, but the pressure would be about 5x greater than Earth.
4. (5 pts) The angular velocity of Jupiter and Saturn is larger than Earth, and so is their radius. The combination increases the velocity of the planets' surface and the effect of the Coriolis effect. The surface of Jupiter doesn't interact with the atmosphere in the same way that Earth does.
5. (5 pts) According to the Berkeley link provided; at the high temperatures and pressures found on Neptune and Uranus methane can condense into diamonds, which then fall ("rain") towards the center of the planet.
6. (5 pts) Uranus's spin is retrograde and the spin axis is nearly in the ecliptic. The strange inclination may have been caused by a glancing impact by a planet-sized object.
7. (10 pts) <http://www.solarviews.com/raw/jup/jupiter2.tif>

Essay questions (6 pts each)

- a) Volcanoes do emit H (~1%) and trace amounts of He.
- b) The atmosphere is depleted of H₂.
- c) Earth's low gravity and high temperature combine to make the escape velocity of H less than its mean velocity in the atmosphere.
- d) Jupiter's low temperature and high gravity combine to make the escape velocity of H greater than its mean velocity in the atmosphere.
- e) Molecular H is a diatomic gas of two atoms a molecule with localized electrons. Metallic H is a lattice of many protons with OUT localized electrons.

f) According to the phase diagram on the second page of the link provided, temperatures $> 5,000$ K and densities > 0.3 g/cc

g) Numerical (computer) models can be used. High-pressure cells (diamond anvils) can be used to make some measurements.

h) There are several methods of producing H gas, for example combining high temperature steam and iron strips the O from the water to create rust and H gas. More typically natural gas (methane) is heated with steam to create carbon monoxide (CO) and H.

i) The Galileo probe had a mass spectrometer and measured the abundance of He directly.

j) They are contracting. This converts potential energy (gravity) into heat and radiation.